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EXAMINER

KIELIN, ERIK-J

ART UNIT PAPER NUMBER

2813

DATE MAILED: 09/10/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/994,954

Applicant(s)

CABRAL, ET AL.

Examiner

Erik Kielin

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-- Th MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 30 June 2003.
- 2a) ☒ This action is FINAL. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 23-28 and 31-41 is/are pending in the application.
- 4a) Of the above claim(s) 24 and 32-35 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 23, 25-28, 31 and 36-41 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ 6) ☐ Other: _____

DETAILED ACTION

This action responds to the Amendment filed 30 June 2003 (Paper no. 13).

Claim Rejections - 35 USC § 112

1. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

2. Claim 40 is rejected under 35 U.S.C. 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention. Claim 40 provides the limitation that, in *electrical contact*, the Si-Ge has lateral edges which do not substantially extend beyond the lateral edges of the metal disilicide. Applicant indicates that Fig. 1F provides support for this new limitation. (See Applicant's Response filed 22 October 2002, p. 4, third paragraph.) Examiner respectfully disagrees. First, the specification indicates that the method is for forming CMOS devices (specification, p. 1, lines 9-13) and for forming electrical contacts to semiconductor substrates (Abstract; claims). Moreover, the specification indicates that Figs. 1A-1F are merely cross-sections (specification, p. 6, lines 8-10) which clearly fail to show any electrical contact structure. Inasmuch as Fig. 1F fails to show any feature of the device being formed but instead merely shows the order of the layers in cross-section, Applicant has not enabled how one of ordinary skill could perform the instant invention of preventing the edges of the metal disilicide from extending beyond the interlayer --especially in light of diffusion. Moreover, Applicant has failed to show how the feature of the contact structure was

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the intention of the invention since there is no written description of this feature, as required under 35 USC 112(1).

3. Claims 23, 25-28, 31-39, and 41 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the enablement requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention.

Regarding claims 23 and 41, the specification does not provide support for the newly added limitation, "where said Si-Ge interlayer has a Ge concentration ranging from about .01 atomic percent to about 9.0 atomic percent" (claim 23) or from about 0.01 atomic percent to about 2.0 atomic percent (newly submitted claim 41). Applicant indicates at p. 10 of Amendment C (Paper no 13, filed 30 June 2003) that support for this new limitation can be found in the specification at p. 9, second paragraph. However, there is absolutely no mention in this paragraph or at any other location in the specification found by Examiner that indicates the concentration of Ge in the final Si-Ge interlayer. Since no range is described anywhere in the four corners of the present disclosure, one of ordinary skill would have no way of knowing how to make or use a Si-Ge interlayer having the range instantly claimed. Instead the specification is drawn to the concentration of the Ge concentration in the metal-germanium alloy initially deposited on the substrate at p. 9, second paragraph and at p. 15, last paragraph. No mention is made about the concentration of the Ge once it diffuses into the Si substrate to form the Si-Ge interlayer.

The remaining claims are rejected for depending from above rejected claim 23.

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

5. Claims **23**, 25-27, 31, 36, 41 and **40** are rejected under 35 U.S.C. 103(a) as being unpatentable over US 5,710,450 (**Chau et al.**) in view of US 5,830,775 (**Maa et al.**).

Chau discloses an electrical contact to a region of a silicon-containing substrate comprising,

a substrate **300** of silicon having an “exposed region” of silicon (region below dotted line in Fig. 3B) wherein the substrate is doped silicon (col. 4, lines 17-21) --as further limited by instant claim 31-- and the substrate must be one of amorphous, polycrystalline, or single crystal --as further limited by instant claim 25-- because these are the only forms that exist; and

a first layer of metal silicide **320** (col. 7, lines 27-44) wherein said metal of said silicide is selected from the group consisting of Ti, Co, and mixtures thereof, and said substrate and said first layer are separated by a Si-Ge interlayer **314** (paragraph bridging cols. 6-7) having from 10% to 50% Ge in an exemplary embodiment (col. 5, lines 60-63) --which is about 9 at%. (See Figs. 3C and 3F.)

Chau does not indicate that the silicide is the “disilicide” and does not indicate that the metal disilicide has an additive.

Maa teaches a method of forming metal silicide contacts to the source/drain regions of a transistor (Figs. 1-10; col. 2; lines 39-41), just as does **Chau**. **Maa** teaches that the silicides may

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be formed from a metal alloy comprising Co, Ti, mixtures of Co and Ti, as well as Ni, W, Pt, Pd, Mo, and Ta (paragraph bridging cols. 4-5) --as further limited by instant claims 36-38-- wherein the Co and Ti silicides are disilicides (col. 9, lines 7-52) --as further limited by instant claims 26 and 27.

It would have been obvious for one of ordinary skill in the art, at the time of the invention to use the disilicides as the **Chau** silicides because the disilicides are the low resistivity phase of the metal silicide, as taught by **Maa** (col. 9, lines 6-52).

It would have been obvious for one of ordinary skill in the art, at the time of the invention to use an additive in the silicide of **Chau** because **Chau** indicates that other metals may be used (Chau, col. 7, lines 43-44) and because **Maa** states that it would be known to one of ordinary skill use mixtures of metals to form a silicide. Further in this regard, the selection of a known material based on its suitability for its intended use is *prima facie* obvious. The selection of a known material based on its suitability for its intended use supported a *prima facie* obviousness determination in *Sinclair & Carroll Co., Inc. v. Interchemical Corp.*, 325 U.S. 327, 65 USPQ 297 (1945) (Claims to a printing ink comprising a solvent having the vapor pressure characteristics of butyl carbitol so that the ink would not dry at room temperature but would dry quickly upon heating were held invalid over a reference teaching a printing ink made with a different solvent that was nonvolatile at room temperature but highly volatile when heated in view of an article which taught the desired boiling point and vapor pressure characteristics of a solvent for printing inks and a catalog teaching the boiling point and vapor pressure characteristics of butyl carbitol. "Reading a list and selecting a known compound to meet known

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requirements is no more ingenious than selecting the last piece to put in the last opening in a jig - saw puzzle." (65 USPQ at 301). (See MPEP 2144.07.)

Regarding claim 39, **Chau** does not teach that the additive is present in the metal disilicide in an amount of from about 0.1 to about 50 atomic percent. **Maa** teaches in "EXAMPLE 2" in col. 9 that the silicide is formed from a mixed layer of Co and Ti wherein the Co thickness is 150 Å and the Ti layer is 44 Å thick. Given the near identical atomic diameters (i.e. densities) of Co and Ti, the atom percent of Ti is seen to be $44/(44 + 150) \cdot 100 = 23 \text{ at\%}$, which is within 0.01 to 50 atom percent.

It would have been obvious for one of ordinary skill in the art, at the time of the invention to use the amount of additive of **Maa** in the silicide of **Chau** because **Maa** teaches that it is known to one of ordinary skill to use metal alloys and shows that 23% is exemplary for such additives. Moreover, although the range is not recited, this claim is *prima facie* obvious without showing that the claimed range achieves unexpected results relative to the prior art. See *In re Woodruff*, 16 USPQ2d 1935, 1937 (Fed. Cir. 1990). See also *In re Boesch*, 205 USPQ 215 (CCPA) (discovery of optimum value of result effective variable in known process is ordinarily within skill of art) and *In re Aller*, 105 USPQ 233 (CCPA 1955) (selection of optimum ranges within prior art general conditions is obvious). One of ordinary skill would be motivated to optimize the amount of additive in the metal in accordance with precedent.

Regarding claim 40, **Chau** teaches lateral edges of the metal silicide **320** do not extend beyond the Si-Ge interlayer **314** (Fig. 3F).

Regarding claim 41, if it is thought that claim 41 is somehow enabled as to the concentration of Ge in the Si-Ge interlayer being from about 0.01 to about 2.0 atomic percent,

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then this may be a difference. However, although the range is not recited, this claim is *prima facie* obvious without showing that the claimed range achieves unexpected results relative to the prior art. See *In re Woodruff*, 16 USPQ2d 1935, 1937 (Fed. Cir. 1990). See also *In re Boesch*, 205 USPQ 215 (CCPA) (discovery of optimum value of result effective variable in known process is ordinarily within skill of art) and *In re Aller*, 105 USPQ 233 (CCPA 1955) (selection of optimum ranges within prior art general conditions is obvious).

6. Claim 28 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Chau** in view of **Maa** and considered with US 5,510,295 (**Cabral, Jr. et al.**) for a showing of inherency.

Neither **Chau** nor **Maa** state that the TiSi_2 is in the C54 phase, but **Maa** shows in “EXAMPLE 2” in col. 9 that the second annealing to form the TiSi_2 is performed at a temperature of 800 °C. Cabral teaches that temperatures 750 °C and higher will convert the TiSi_2 to the C54 phase. Accordingly, it is seen to be inherent that the silicide of Chau in view of **Maa** is in the C54 phase because the anneal temperature is high enough for this to occur.

Response to Arguments

7. Applicant's arguments filed 30 June 2003 (Paper no. 13) have been fully considered but they are not persuasive.

On pages 5 through 7, Applicant argues that claim 40 is enabled. While the arguments have been considered, Examiner respectfully disagrees that the claim is enabled. In support of this argument, Applicant argues in technical support of the argument at p. 7, last paragraph,

“The disclosed annealing temperature range [of about 400 °C to about 700 °C] provides enough thermal energy to produce the SiGe interlayer

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by diffusing Ge to the interface between the metal silicide and the substrate; but does not provide enough energy to diffuse the Ge into the Si substrate.”

Examiner respectfully submits that this statement is in error. First, an Si-Ge interlayer cannot be produced that is up to 3.0 nm (30 Å) which is at least about 20 monolayers thick (given the covalent radius of Si is 1.1 Å and that of Ge is 1.22 Å), if the Ge does not penetrate into the Si substrate. Accordingly, if diffusion does not occur into the substrate, as Applicant has argued, then Applicant is clearly providing erroneous information regarding (1) the formation of the Si-Ge interlayer in the first place; and (2) the thickness of the Si-Ge interlayer. It simply defies common sense to suggest that the Si-Ge interlayer forms by diffusion of the Ge, but that the Ge somehow fails to diffuse into the very material (Si substrate) that enables the formation of the material Si-Ge. Additionally, since diffusion occurs in three dimensions, the Ge would diffuse past the edges of the metal disilicide.

Moreover, this information is merely a conclusory observation submitted by Applicant's Representative. It is noted that MPEP 2145 states “argument does not replace evidence where evidence is necessary.” These statements by Applicant's Representative do not constitute evidence.

Finally, as repeated from Applicant (as noted above in the rejection), support for the metal disilicide not extending beyond the lateral edges of the metal disilicide is found from Fig. 1F. But the instant specification states that Figs. 1A-1F are merely cross-sections. Accordingly, Fig. 1F shows no lateral edges of a contact structure.

Regarding the rejection under 35 USC 103(a), each of Applicant's arguments on pages 7 through 9 are based upon the allegation that Chau does not teach the limitation that the lateral

edges of the Si-Ge layer do not extend beyond the metal disilicide. Examiner respectfully disagrees and respectfully submits that this is shown to every extent that the instant Fig. 1F shows this. Moreover, it is noted that the instant specification does not enable this limitation. Accordingly, these arguments are moot.

On pages 10-11 Applicant argues that Chau does not teach the claimed concentration of Ge in the SiGe interlayer as presently claimed, but the instant specification provides no such range and is not enabled. Accordingly, the argument is moot.

Conclusion

8. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the date of this final action.

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Any inquiry concerning this communication or earlier communications from the examiner should be directed to Erik Kielin whose telephone number is 703-306-5980. The examiner can normally be reached on 9:00 - 19:30 on Monday through Thursday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead, Jr., can be reached at 703-308-4940. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9318 for regular communications and 703-872-9319 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.



Erik Kielin
Primary Examiner
September 9, 2003